REMARKS/ARGUMENTS

The Office Action of February 10, 2006 has been reviewed and carefully considered.

Reconsideration of the above-identified application, as herein amended, is respectfully requested.

Status of Claims:

Claims 1 to 15 are pending in the application, with claims 1, 10 and 15 being the only independent claims. New independent claim 15 has been added.

Claims 10 to 14 have previously been withdrawn from consideration.

Overview of the Office Action:

The drawings have been objected to under 37 CFR §1.83(a) on the ground that they fail to show "the given direction running parallel to said radiation exit face and at least one of said side faces forming an angle between 40° and 50° with said given direction".

Claim 1 stands rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement, on the ground that the application as originally filed "does not adequately describe the principal crystal directions as it does not indicate whether there are only two principal crystal directions or there is a third principal crystal direction which is not shown in Fig. 1."

Claims 3 and 7 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement on the ground that "the specification does not disclose how the at

least one of said side faces can form an angle between 40° and 50° with a principal crystal direction which runs parallel to a radiation exit face."

Claims 3 and 7 stand rejected under 35 U.S.C. §112, second paragraph, as indefinite for failing to particularly point out and distinctly claim "how a side face which is perpendicular to a radiation exit face can be disposed obliquely or form an angle of between 40° and 50° or 45° (as in claim 7) with a principal crystal direction which runs parallel to said radiation exit face."

Finally, claims 1, 2, 4 to 6, 8 and 9 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 6,483,860 to *Ueki et al* ("*Ueki*").

Summary of Subject Matter Disclosed in the Specification:

The following descriptive details are based on the specification. They are provided only for the convenience of the Examiner as part of the discussion presented herein, and are not intended to argue limitations which are unclaimed.

The specification discloses a surface-emitting semiconductor laser chip in which at least one of the side faces of the semiconductor body is disposed obliquely with respect to the two principal crystal directions of the semiconductor body which extend along a lateral direction of the radiation exit face.

As explained in the application specification, the designations "surface" and "side face" are associated with the fabrication of laser chips in a wafer composite, the "surface" corresponding to the wafer surface. The side faces, by contrast, are only produced when the semiconductor wafer is divided into individual semiconductor chips. (See Paragraph [0003] of the published specification).

In a customary, i.e. prior art, method for producing edge emitting laser chips, a wafer is usually broken in order to be divided into individual semiconductor ships, the breaking line running

along a principal crystal direction of the wafer. This gives rise to side faces of the semiconductor bodies in the form of smooth cleavage faces that are simultaneously mirror facets of the respective laser resonators. (See Paragraph [0004] of the specification).

However, it has been ascertained in the case of light-emitting diode chips that a frequent aging mechanism is based on dislocation lines that arise in the semiconductor crystal. The dislocation lines can propagate during operation and form nonradiative recombination centers. Such crystal effects lower the efficiency of the device and may finally lead to failure. In the luminescent image of a semiconductor crystal, such crystal defects are seen as dark lines, and so they are also commonly referred to as dark line defects (DLDs). (See Paragraph [0006] of the specification).

The present invention reduces the occurrence of DLDs and provides improved aging behavior or an increased lifetime of the semiconductor laser chips. It has in accordance with the invention been found that, in dividing the wafer into individual semiconductor chips, disposing the side faces of the chips *obliquely* with respect to the principal crystal directions - instead of *along* a principal crystal direction - has the advantage that fewer seeds for dislocation lines arise in the crystal structure and the number of dislocation lines thus decreases. This advantageously slows down the aging of the semiconductor chip. (See, e.g. Paragraphs [0009] and [0026] of the specification).

Descriptive Summary of the Prior Art:

Ueki discloses a surface emitting semiconductor laser with an oxidized post structure, including a substrate 10 on which a first reflecting mirror 12 is disposed. A cylindrical post part 24 has an active spacer region 14 disposed on the mirror 12 and a selective oxidation layer 16 on the

spacer 14. A second reflecting mirror 18 is disposed on the layer 16. A contact layer 20 is disposed on the second reflecting mirror 18. (See Figs. 1A and 1B of *Ueki*).

Arguments:

Objection to the Drawings:

Applicants respectfully disagree with Examiner's contention that "the given direction running parallel to said radiation exit face and at least one of said side faces forming an angle between 40° and 50° with said given direction" is not shown in the drawings. Fig. 1 of the instant application depicts two principal crystal directions 7 as extending toward and meeting or intersecting the edge of each of the side faces 5 at an angle of between approximately 40° and 50°. This is also shown in Fig. 3, in which the interception angle of each of the principal directions [010] and [100] with a respective side face 5 is expressly identified in the drawing as "45°". This depiction in the drawings is in accord with and supports the recitiation in each of applicants' claims, that "at least one of said side faces [is] disposed obliquely with respect to the principal crystal directions".

Moreoever, as shown in each of Figs. 1 and 3, each of the principal directions 7 (Fig. 1) or [010] and [100] (Fig. 3) intercepts one of the side faces obliquely and, as expressly stated in Fig. 3, at an angle of 45° which lies between 40° and 50°. This angular relationship as depicted in the drawings is further supported and explained in Paragraphs [0011] and [0032] of the published specification.

Thus, applicants believe that the drawings already show the claimed feature, that no amendment or correction of the drawings is either necessary or should be required, and that the objection to the drawings under 37 CFR 1.83(a) should be withdrawn.

Objections to the Claims Under 35 U.S.C. §112, First and Second Paragraphs:

Applicants disagree with the Examiner's contentions that the application specification fails to comply with either the written description or enablement requirements, or that certain claims are indefinite as failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention.

As the Examiner is aware, the principal crystal directions - which are also commonly referred to as the crystal axis reference orientations - are determined by the structure of the particular crystal, more particularly by the type of Bavais lattice on which the crystal structure is based. Generally, a three-dimensional crystal has three principal crystal directions which, in a cubic crystal, are orthogonal with respect to each other. Thus, the principal crystal directions of a cubic crystal can be viewed as generally corresponding to the *x*, *y* and *z* axes of an orthogonal coordinate system, and are often referred to as the respective [100], [010] and [001] crystal directions.

It goes without saying that the cubic semiconductor body of the laser chip of the present invention has three principal directions, each orthogonal to the others. In the present invention, however, only the two principal crystal directions that run laterally along the radiation exit face are relevant to the advantageous ability to decrease dark line defects in the inventive surface emitting semiconductor laser chips in accordance with the invention. Thus, only those two principal crystal directions 7 (in Fig. 1) or [100] and [010] (in Fig. 3) are shown in the drawings, discussed in the application specification and recited in the claims. That the semiconductor body of applicant's laser chip has three principal directions is apparent to those of ordinary skill in the relevant art. Equally apparent to the person of skill, based on applicants' disclosure, is that it is the two principal crystal directions shown in the drawings and discussed in applicant's specification - i.e. those which extend along a lateral direction of the radiation exit face (Fig. 1), or put another way those extending in the

[100] and [010] directions (Fig. 3) - which are relevant to applicant's invention. Applicants' written description in this regard reasonably conveys to one skilled in the relevant art that the inventors, at the time that the application was filed, had possession of the claimed invention, the accordingly satisfies the written description requirement of 35 U.S.C. §112, first paragraph.

Although applicant's believe that the written description requirement 35 U.S.C. §112, first paragraph, is fully satisfied in respect of claim 1, for enhanced clarity applicants have amended claim 1 to expressly recite that the principal directions extend "along a lateral direction of the radiation exit face" of the semiconductor body comprising the claimed surface emitting semiconductor laser chip. This clarification is also present in applicants' newly-added independent claim 15. That this amended recitation is supported by the written description of the present application is beyond peradventure.

The section 112, first paragraph, rejection of claim 1 based on the written description requirement is accordingly deemed satisfied, and its withdrawal is requested.

With respect to 35 U.S.C. §112, first paragraph, enablement rejection of claims 3 and 7, the Examiner is referred to the discussion above relating to the objection to the drawings. Each of Figs. 1 and 3 clearly depict the principal crystal directions 7 (Fig. 1) or [100] and [010] (Fig. 3) extending to an interception with one of the side faces 5 at an angle between 40° and 50° (Fig. 1) and, as identified in Fig. 3, an angle of 45°. (See also Paragraphs [0011] and [0032] of the specification.)

Thus, applicants believe that the 35 U.S.C. §112, first paragraph, enablement rejection of claims 3 and 7 should be withdrawn.

Applicants further believe that the Examiner's 35 U.S.C. §112, second paragraph, indefiniteness rejection of claims 3 and 7 is unsupported by the application disclosure. The Examiner is seeking an explanation as to "how a side face which is perpendicular to a radiation exit

face can be disposed obliquely or form an angle between 40° and 50° or 45° (as in claim 7) with a principal crystal direction which runs parallel to said radiation exit face."

The manner in which this language of claims 3 and 7 is met by applicant's invention can be seen in the drawings. With reference, for example, to Figs. 1 and 2 of the drawings, the side face 5 is shown as perpendicular to the radiation exit face 4. The two principal crystal directions 7 each extend to intercept a side face 5 at an angle between 40° and 50°, or 45° as indicated in Fig. 3. The principal crystal directions 7 also extend parallel to the radiation exit face 4.

Thus, the subject matter questioned by the Examiner is in fact depicted in the drawings and disclosed in the specification.

Withdrawal of the 35 U.S.C. §112, second paragraph, rejection of claims 3 and 7 is accordingly deemed appropriate.

35 U.S.C. §102 Rejection of Claims 1, 2, 4 to 6, 8 and 9

Claims 1, 2, 4 to 6, 8 and 9 stand rejected under 35 U.S.C. §102(b) as allegedly anticipated by *Ueki*.

Ueki, however, fails to contain *any* description, or teaching, or suggestion that its principal crystal directions which extend along a lateral direction of the radiation exit face are so oriented that at least one of the side faces laterally delimiting the semiconductor body is disposed obliquely with respect to those principal crystal directions. Indeed, *Ueki* contains no teaching or suggestion *whatsoever* as to any intended or required orientation of the crystal axes relative to a side face of the semiconductor body. Instead, *Ueki* discloses that the main face of the semiconductor substrate is *tilted* with respect to a face containing a reference crystal axis. As *Ueki* explains:

> "As shown in FIGS. 1A and 1B, a surface emitting semiconductor laser of a first embodiment is a surface emitting semiconductor laser device of top face emission type that has a cylindrical post part 24 with an active region 14 and a selective oxidation layer 16 formed, and its substrate has a crystallographic face orientation of approximately 2° off, which is an angle formed by a tilt (100) to the [110] direction which is the direction of the normal to the (110) shown in FIG. 2A." (Col. 5, ll. 20-28).

Ueki further teaches that, although the crystallographic face orientation of approximately 2° off is preferred, "a range from –5° to 5° is reasonable." (Col. 7, l. 24). Nowhere and nothing in *Ueki* provides *any* teaching or suggestion for orienting the principal crystal directions that extend along a lateral direction of the radiation exit face so that at least one of the side faces of the semiconductor body is disposed *obliquely* with respect to those principal crystal directions, as recited in each of applicants' claims.

Applicants also point out that FIG. 2B of *Ueki* merely depicts the "crystalline orientation of a semiconductor *wafer*" (See Col. 5, ll. 28-29). The mere depiction of a semiconductor wafer in FIG. 2B of *Ueki* in *no* manner teaches or suggests the way in which individual semiconductor chips will or should be defined from that wafer, or the way in which the principal crystal directions which extend lateral to the face of the wafer may or should be oriented with respect to the resulting side faces of the semiconductor chips when the individual chips are cut from the wafer.

The principal crystal directions are directions which are defined during growth of the semiconductor mass from which a wafer is produced. The semiconductor wafer provides semiconductor material of a particular crystal structure from which a plurality of semiconductor chips can be cut or defined; FIG. 2B of *Ueki* merely depicts such a wafer. To produce the semiconductor chips, this wafer must be divided into a plurality of individual semiconductor

chips. In accordance with the prior art, a wafer is conventionally divided *along* a principal crystal direction which results in a first crystal direction running *parallel* and a second crystal direction running *perpendicular* to the side face. In contrast, in accordance with the present invention the division of the wafer into semiconductor chips is carried out so that at least one side face is disposed *obliquely* with respect to the principal crystal directions that extend along a lateral direction of the radiation exit face. Thus, the oblique orientation of the side face with respect to the principal crystal directions which extend along a lateral direction of the radiation exit face in accordance with the present invention *results from the way in which the wafer is divided* -- a process and resulting semiconductor chip body which is *nowhere* described or suggested by the *Ueki* reference. The mere illustration of a wafer in *Ueki* FIG. 2B in no manner depicts any particular arrangement or orientations of the principal crystal directions in a semiconductor chip that is produced from that wafer when it is divided into single chips, and *Ueki* fails to describe or show how the wafer of FIG. 2B should be divided into semiconductor chips.

Ueki accordingly lacks any teaching or suggestion to anticipate - or, indeed, to render obvious - applicants' claimed recitation that the principal crystal directions which extend along a lateral direction of the radiation exit face are oriented so that at least one of the side faces is disposed obliquely with respect to those principal crystal directions.

Withdrawal of the rejection of claims 1, 2, 4 to 6, 8 and 9 under 35 U.S.C. §102(b) as anticipated by *Ueki* is therefore respectfully requested.

Newly-Submitted Claim 15:

Independent claim 15 is deemed allowable for at least the same reasons discussed above with respect to claim 1. In particular, claim 15 recites, *inter alia*, a surface emitting semiconductor laser chip comprising a semiconductor body in which principal crystal directions that extend along a lateral direction of the radiation exit face are oriented so that at least one of the side faces which laterally delimit the semiconductor body is disposed obliquely with respect to those principal crystal directions.

Allowance of claim 15 is accordingly also therefore requested.

Conclusion:

Based on all of the foregoing, it is respectfully submitted that the present application is now in full and proper condition for allowance. Prompt and favorable action to this effect, and early passage of this application to issue, are once more solicited.

Should the Examiner have any comments, questions, suggestions, or rejections, the Examiner is respectfully requested to telephone the undersigned in order to facilitate the prompt resolution of any outstanding issues.

It is believed that no fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 03-2412.

Respectfully submitted,

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